Course:-
Electrical Network
Analysis

Module :. 4th Semester.

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Question No 1:-

Assume that a 2000-KW turbine generator of 0.85 power factor operates at the rated load.

→ An additional load of 300KW at 0.8 power factor is added. What KVAR of Capacitor is requried to operate the turbine generator but keep it from being overload?

⇒ Solution:-

Original load:-

$P_1 = 2000\ kW$. $\cos\theta_1 = 0.85$

$\theta_1 = 31.79°$

$S_1 = \frac{P_1}{\cos\theta_1} = 2352.94 KVA$

$Q_1 = S_1 \sin\theta_1 = 1239.5 KVAR$

Additional load:

$P_2 = 300kW \quad \cos\theta_2 = 0.8 \rightarrow$
$\theta_2 = 36.87°$

$$S_2 = \frac{P_2}{\cos\theta_2} = 375 \text{ KVA}$$

$Q_2 = S_2 \sin\theta_2 = 225 \text{KVAR}$

Total load:
$S = S_1 + S_2 = (P_1 + P_2) +$
$j(Q_1 + Q_2) = P + jQ$

$P = 2000 + 300 = 2300 \text{ KW}$

$Q = 1239.5 + 225 = 1464.5 \text{KVAR}$

Minimum operation pf for a 2300 KW load and not exceeding the KVA rating of the generator is

$$\cos\theta = \frac{P}{S_1} = \frac{2300}{2352.94} = 0.9775$$

or $\theta = 12.177°$

The maximum load KVAR for this condition is :-

$$Q = S_1 \sin Q = 2352.94 \sin.$$

$$Q = 496.313 \text{ KVAR}.$$

The capacitor must supply the difference between the total KVAR. (i-e Q) and the permissiable generator KVAR Thus,

$$Q_c = Q - Q_m = 968.2 \text{ KVAR}.$$

Question No 4:-

Apply laplace transform and calculate the output voltage $V_o(t)$ in the circuit of figure below.

Solution:-

At node 1

$$\frac{\frac{10}{s} - V_1}{1} - \frac{V_1 - V_o}{s} + \frac{s}{2}V - 10 = (s+1)V_1$$

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$$\frac{S+1}{(S+1)^2 + 0.7071^2} - 1.414\frac{0.7071}{(S+1)^2+0.7071}\Bigg]$$

Taking the inverse laplace transform

$$V_o(t) = \frac{20}{3}\Big[1-e^{-t}\cos 0.7071t - 1.414e^{-t}\sin 0.7071t\Big]u(t)\,V\Big]$$

Question No 5:-

Solutions-

Source impedance $Z_1 - R_1 - jX_2$

Load impedance $Z_L = R_L + jX_2$

for maximum load transfer

$Z_L - Z_2^\circ \rightarrow R_1 - R_L, X_L - X_L$

or $\omega = \frac{1}{\sqrt{LC}} = 2\pi f$

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$Z_L - Z^\circ \rightarrow R_1 - R_L,\ X_L - X_L$

or $\omega = \frac{1}{\sqrt{LC}} = 2\pi f$

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(80\times10^{-3})(40\times10^{-9})}}$$

$$= 2.814\ KHZ$$

(b) $P = \left[\frac{V_s}{10+4}\right]^2 4 = \left[\frac{4.6}{14}\right]^2 4 = 431.8mW$

(sin V_s is in rms).

Question No 2:-

A balanced abc sequence one line voltage of a balanced Y-connected source is $V_{AB} = 180\angle-20^\circ$ V. If the source is connected to a Δ-connected load of $20\angle40^\circ\ \Omega$, find that phase and line currents?

Solution:-

Line voltage $V_{AB} = 180\angle-20^\circ V$

$Z_\Delta = 20\angle40^\circ\ \Omega$

Using formula.

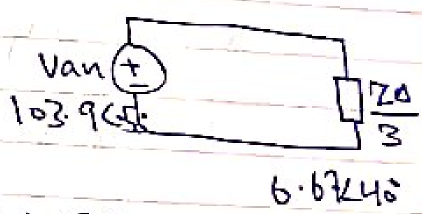
$V_L = \sqrt{3}V_p\angle30^\circ \Rightarrow V_p = \frac{V_L}{\sqrt{3}\angle30^\circ}$

$$V_{an} = \frac{180\angle -20^\circ}{\sqrt{3}} \cdot \angle -30^\circ = 103.9\angle -50^\circ V$$

$$Z_y = \frac{Z_\Delta}{3} = \frac{20\angle 40^\circ}{3} = 6.67\angle 40^\circ \Omega$$

Line current:-

$$I_a = \frac{V_{an}}{Z_a/3} = \frac{103.9\angle -50^\circ}{6.67\angle 40^\circ}$$



$$I_a = \frac{V_{an}}{Z_a/3} = \frac{103.9\angle -50^\circ}{6.67\angle 40^\circ}$$

$$I_b = I_a \angle -120^\circ = 15.59\angle +150^\circ A$$

$$I_c = I_a \angle +120^\circ = 15.59\angle 30^\circ A$$

Phase current:

$$I_{AB}\ 15.57\angle -90^\circ \cdot \angle 30^\circ = 9\angle -60^\circ A$$

$$I_{BC} = I_{AB} \angle -120^\circ = 9\angle -180^\circ A$$

$$I_{CA} = I_{AB} \angle +120^\circ = 9\angle 60^\circ A.$$

Question No 3:-

Solution:-

$V_{rms} = 110\angle 85^\circ V.$

$I_{rms} = 0.4\angle 15^\circ A.$

The complex power is

(a) $S = V_{rms} I^*_{rms}$

$S = (110\angle 85^\circ)(0.4\angle -15^\circ)$

$S = 110 \times 0.4\angle(85^\circ - 15^\circ)$

$S = \underline{\underline{44\angle 70^\circ \, VA}}$

The apparent power is

$S = |S|$

(c) The power factor is

$$pf = \cos(70^\circ)$$

$\therefore$ $\underline{pf = 0.342 \text{ lagging}}$

The power factor is lagging as the reactive power is positive.

The load impedance is:

$$Z = \frac{V}{I}$$

$$V = \sqrt{2} V_{rms}$$

$$I = \sqrt{2} I_{rms}.$$